

# CANADIAN NETWORK ENABLED OPERATIONS INITIATIVES

Mr. Sandy Babcock  
Defence Scientist  
Directorate Defence Analysis  
National Defence Headquarters  
101 Colonel By Drive  
Ottawa, Ontario, Canada K1A 0K2  
[Babcock.aa@forces.gc.ca](mailto:Babcock.aa@forces.gc.ca)

## ABSTRACT

This paper provides an overview of network enabled operations (NEOps) issues and initiatives within the Department of National Defence/Canadian Forces and how it has or will facilitate transformation. This includes discussion on the results of efforts to decompose NEOps to identify areas of fruitful research and development, and the status of efforts to address such areas. Moreover, this paper seeks to map the impact of NEOps to the department's PRICIE construct (equivalent to the US DOTMLP framework) and discuss concept development and experimentation related to this theory. Moreover, information is provided on departmental efforts in relation to C4ISR developments and their implications for NEOps within the context of the 2002 Exercise Robust Ram and the Pacific Littoral ISR Experiment (PLIX) conducted during the summer of 2003. The paper also describes the planning and expectations for an Atlantic Littoral ISR Experiment (ALIX) during August 2004, which will integrate and exploit multiple sensors in an integrated intelligence, surveillance and reconnaissance architecture (IISRA), including the employment of an uninhabited airborne vehicle (UAV), and concludes with discussion on future intentions in this area.

## INTRODUCTION

Network Centric Warfare (NCW) has been embraced by numerous nations and is considered the cornerstone of many of the military transformation initiatives currently seen within the US. Since first proposed by Vice Admiral Arthur K. Cebrowski, US Navy, and John J. Garstka in 1998<sup>1</sup>, it certainly has become clear that NCW has critical implications across the full spectrum of military operations, support organizations, personnel, training and infrastructure. However, despite such global initiative, the Canadian Department of National Defence and Canadian Forces have been slow to formally embrace NCW, or as we define it, Network Enabled Operations (NEOps). This has been for a variety of reasons, including operational tempo, budgetary constraints and other issues taking higher priority. This is in the process of changing.

In response to the evolving security environment, the Canadian Department of National Defence and Canadian Forces are on the verge of adopting a new capstone

---

<sup>1</sup> Vice Admiral Arthur K. Cebrowski, U.S. Navy, and John J. Garstka, "Network-Centric Warfare: Its Origin and Future", *Proceedings of the Naval Institute*, Vol. 128, No. 1 (January 1998), pp. 28-35.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>JUN 2004</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2004 to 00-00-2004</b>	
4. TITLE AND SUBTITLE <b>Canadian Network Enabled Operations Initiatives</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>National Defence Headquarters, Directorate Defence Analysis, 101 Colonel By Drive, Ottawa, Ontario, Canada K1A 0K2, ,</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>The original document contains color images.</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES <b>50</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

Canadian Forces Strategic Operating Concept (SOC),<sup>2</sup> which looks to define the principles and attributes that need to be adopted to create the conditions for future success. As depicted in Figure 1, network enabled operations are anticipated to play an integral part of future Canadian military operations.

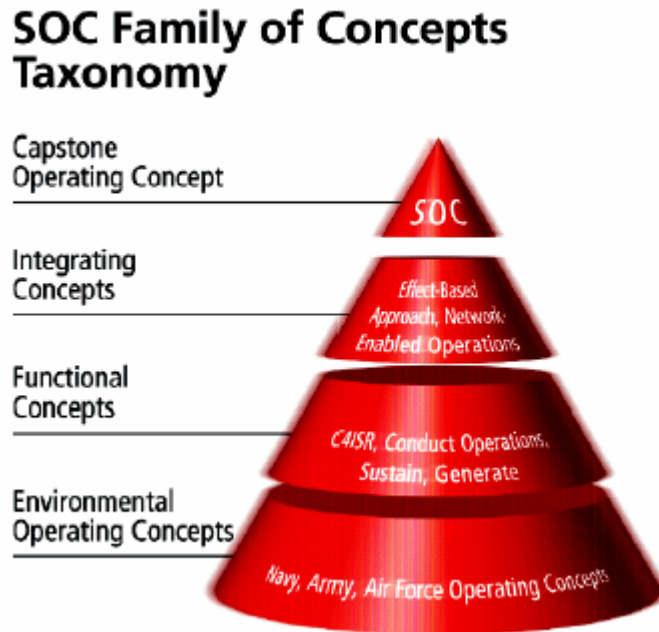


Figure 1: Hierarchy of SOC Concepts

As part of this future environment, it is anticipated that military operations will be Joint, Interagency, Multinational and Public (JIMP) (Figure 2 refers). Within the JIMP

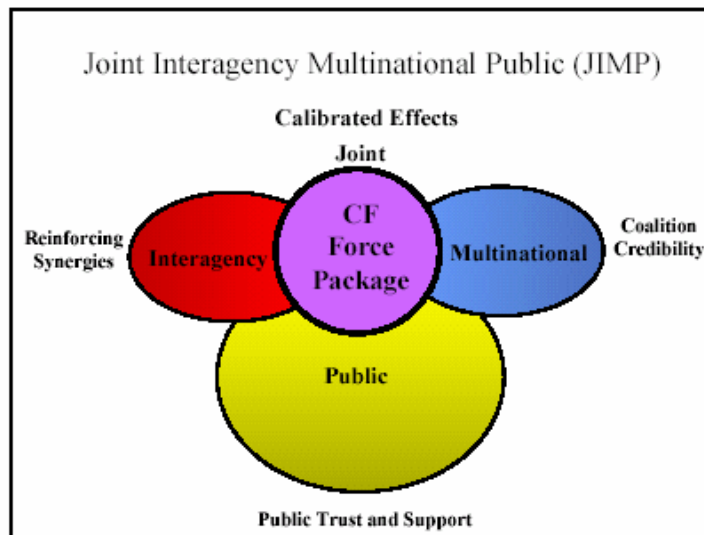


Figure 2: JIMP Depiction

<sup>2</sup> Canadian Forces Strategic Operating Concept, Version 4.0, 26 March 2004.

construct, Joint refers to activities and operations involving more than one service. Interagency relates to the collaborative efforts of the full range governmental departments and actors, as well as those of national and international nongovernmental and commercial entities. Multinational in this instance relates to the activities, organizations and operations of allies and coalition partners. Public indicates that national and international public opinion must be considered in the conduct of military operations.<sup>3</sup> NEOps will be critical to the provision of JIMP in this future environment.

The purpose of this paper is to describe past, current and future initiatives within Canada to develop and adopt NEOps as a major component of departmental efforts to achieve transformation. As part of this, the results of some initial workshops will be described, as will be the results of gap analyses of NEOps to determine areas of fruitful research and development efforts. Subsequently, the findings of a series of experiments will be reported upon and the paper will conclude with discussion on the road ahead.

### **CANADIAN INITIATIVES**

Although not yet formally adopted nationally as a concept in support of transformation, NEOps has received significant attention within the Canadian Department of National Defence and Canadian Forces. It is an important element of departmental efforts to develop the next generation IISRA.<sup>4</sup> Canadian Defence Research and Development centres have been examining this theory from a number of perspectives. Canada also has participated in a number of international forums related to NEOps, including NATO working groups, a range of US Department of Defense Command and Control Research Program initiatives (i.e. the Evidence Based Research Inc. led Conceptual Framework Workshop series), and Military Operational Research Society activities. In addition to participating in The Technology Cooperation Program (TTCP) maritime action group on NCW, Canada co-chaired a TTCP Tiger Team and hosted this team's February 2004 NCW Workshop.<sup>5</sup> Moreover, Canada has cooperated bi-laterally with a number of nations and entities, including Australia, the United Kingdom and United States Joint Forces Command.<sup>6</sup> Finally, Canadians have individually contributed to the development of NCW theory, as demonstrated by the three "cantos" co-written by Canadian Lieutenant Colonel Ralph Giffin presented at the 8<sup>th</sup> Annual CCRT conference.<sup>7</sup>

One of the Canadian centres of NEOps-related work has been the Canadian Forces Experimentation Centre (CFEC). As will be described later in this paper, CFEC has led a series of experiments exploring NEOps. It has also hosted two workshops that

---

<sup>3</sup> Ibid., pp. 5-16.

<sup>4</sup> See, for example, Canadian Forces C4ISR Campaign Plan – Interim Report, Director Joint Force Capabilities, 27 June 2003.

<sup>5</sup> TTCP NAMRAD Principals Action Group on Network Centric Warfare Final Report, 23 February 2004.

<sup>6</sup> See, for example, the joint Australian-Canadian effort by Mathew Fewell & Mark Hazen, *NCW: Its Nature & Modelling*.

<sup>7</sup> Lieutenant Colonel Ralph E. Giffin and Darryn J. Reid, *A Woven Web of Guesses, Canto One: Network Centric Warfare and the Myth of the New Economy, A Woven Web of Guesses, Canto Two: Network Centric Warfare and the Myth of Inductivism, and A Woven Web of Guesses, Canto Three: Network Centric Warfare and the Virtuous Revolution*.

helped educate the Canadian defence community on this theory, developed a draft Canadian definition, performed an initial gap analysis to identify shortfalls in research and development, and completed a PRICIE assessment (equivalent to the US DOTMLTP structure).

For a number of reasons, the term NCW was found to be inadequate for Canadian purposes. For instance, NCW tended to focus attention excessively on the network and its related technology, and seemed to exclude military operations other than war. Additionally, NCW publications do not appear to clearly address how to succinctly define this term.<sup>8</sup> In fact, quite often attempts to define NCW have resulted in something that sounds more like a hypothesis than a definition (i.e. If a networked force improves information gathering and sharing, then this will lead to enhanced situational awareness and self-synchronization and better decision-making, resulting in increased mission effectiveness). The UK term Network Enabled Capabilities seemed to come closer to satisfying Canadian concerns, but the inclusion of “capabilities” appeared to draw attention from the essentially human dimension of war fighting. For these and other reasons, a draft definition was developed indicating that:

Network Enabled Operations (NEOps) represent an approach to the conduct of military operations characterized by common intent, decentralized empowerment and shared information, enabled by appropriate culture, technology and practices.

Whether this definition will be formally adopted by Canada will be determined later.

Between the CFEC workshops and the TTCP-led examination of NCW issues, a number of areas have been identified for research and development efforts. Generally, there is recognition that there is a range of technology issues that need to be resolved associated with the movement of information<sup>9</sup> and how information is handled.<sup>10</sup> Significantly, a major area for research relates to the human and social dimension of NEOps.<sup>11</sup> As a result of this, efforts are ongoing to focus appropriate Canadian research

---

<sup>8</sup> For instance, the seminal David S. Alberts et al, *Network Centric Warfare: Developing and Leveraging Information Superiority* (2<sup>nd</sup> revised edition), 2000, uses six pages (pp. 88-93) to provide a NCW definition that defies attempts to reduce it to something easily quotable.

<sup>9</sup> These include, but are not limited to, building networks that behave like complex adaptive systems; better approaches to engineering federations of systems and scalable “plug and play” approaches; advanced Wideband SATCOM; visualization, virtual displays and smart rooms for gathering information throughout the global information grid (GIG) and converting it to knowledge to achieve a consistent battle space understanding; enhanced security, robustness, trustworthiness, and protection of wide-bandwidth networks; and how to integrate coalition partners into the GIG.

<sup>10</sup> For example, the establishment of a global net-centric surveillance targeting capability; the automatic tagging of selected sensor data; development of a coalition conceptual and technical architecture for linking sensors, decision-makers and effectors; developing how timely, accurate information and sensor fusion from heterogeneous sources can be provided to achieve consistent operational situational awareness.

<sup>11</sup> For instance, research and development is required in relation to the human aspects of developing shared awareness, effective collaboration and synchronization of actions. How is the trust developed to accomplish this? How do multinational teams work together in an NCW environment?; R&D related to self-synchronization is required, including specifically the full range of roles/characteristics of information age C2 and the contribution of ISR integrated with C2 to achieve optimum situational awareness; determination

and development efforts in these areas, as demonstrated by the linkages being developed between CFEC and Defence Research and Development Canada Toronto, where significant human-factor related work has been done in the area of command and control.<sup>12</sup>

Canada uses the PRICIE (Personnel; Research and Development; Infrastructure and Organization; Concepts, Doctrine and Collective Training; Information Management; Equipment, Supplies and Services) construct to decompose capabilities into areas of functional responsibilities, which roughly align with our organizational structure. In November 2003, CFEC hosted a workshop that included an assessment, at the tactical, operational and strategic levels, of the impact of NEOps on the PRICIE structure. Using a scale from 0-4, with 0 representing no impact and 4 representing major impact, it quickly became evident during this event that NEOps is expected to significantly affect how the Canadian Forces will organize, operate, train and fight. The following is a summary of this assessment:

PRICIE Items	Average Scores	Variability
1. Personnel (including professional development and leadership)	3.4	48%
2. Research and development (including operational research)	3.8	27%
3. Infrastructure and Organization	3.4	48%
4. Concepts, Doctrine and Collective Training	3.9	23%
5. Information Management	3.8	27%
6. Equipment, Supplies and Services	3.2	62%

Figure 3: PRICIE Assessment

By averaging these six scores, an average of 3.6 is achieved out of a possible score of four. In reviewing this evaluation, it appears that the individual assessments of the PRICIE components generally showed a limited range of opinions; in the main, workshop participants, who represented a variety of operational and functional backgrounds, came to similar conclusions about the future significant importance of

---

of how cognitive processes affect awareness and shared awareness in military situations; examination of the behaviour of distributed teams in military situations; collaborative processes in military organizations, particularly collaboration across echelons and horizontal functional collaboration (including R&D on collaboration in coalitions (particularly cross-cultural)); the exploration of issues related to sense-making, the factors that influence our sense-making abilities, and how it relates to military situations; R&D into the profound changes that NCW will make in the command and control functions, particularly in circumstances where self-synchronization is possible; training and exercises for national and coalition NCW operations; Human System Integration for accessing and displaying information and on the design and operation of the information system itself. How a coalition develops semantic interoperability (the capability to routinely translate the same information into the same understanding). Further to this and the preceding two footnotes, a more complete listing of NCW/NEOps R&D requirements may be found in the TTCP NAMRAM NCW report, op.cit., pp. 25-29.

<sup>12</sup> For instance, see Carol McCann and Ross Pigeau, *Using the Command and Control Framework to Analyse Command Challenges*.

NEOps to the Department of National Defence and Canadian Forces. These individual assessments follow:

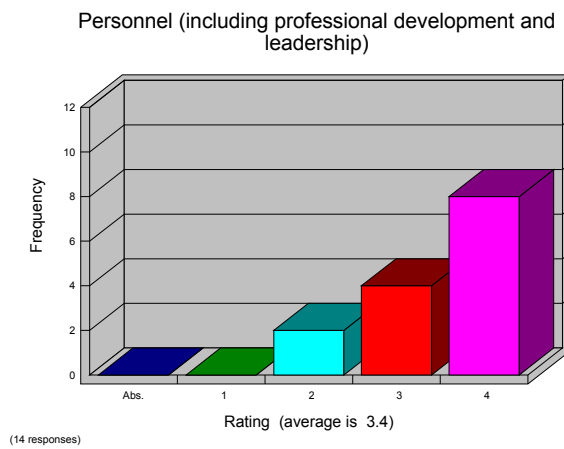


Figure 4: Assessment of NEOps Impact on Personnel

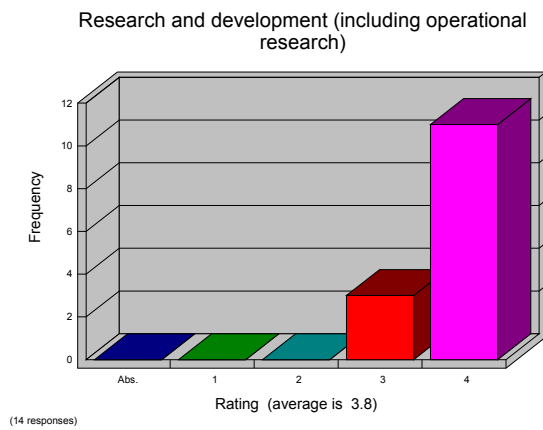


Figure 5: Assessment of NEOps Impact on Research and Development

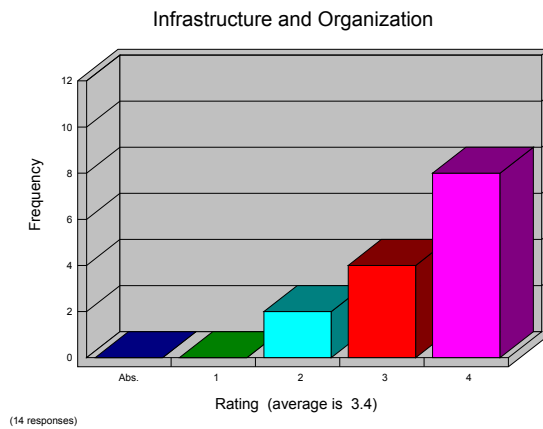


Figure 6: Assessment of NEOps Impact on Infrastructure and Organization

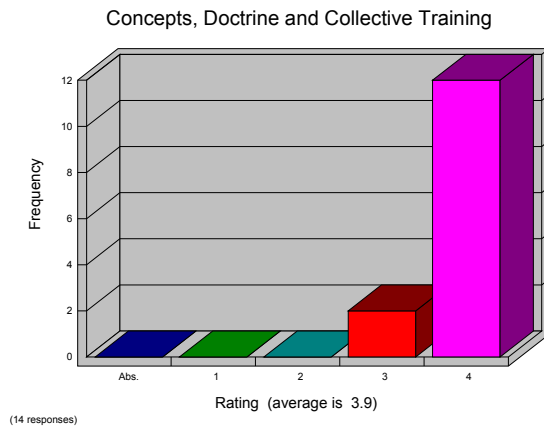


Figure 7: Assessment of NEOps Impact on Concepts, Doctrine and Collective Training

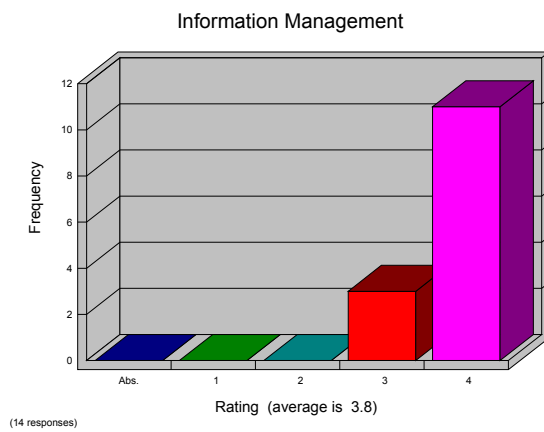


Figure 8: Assessment of NEOps Impact on Information Management

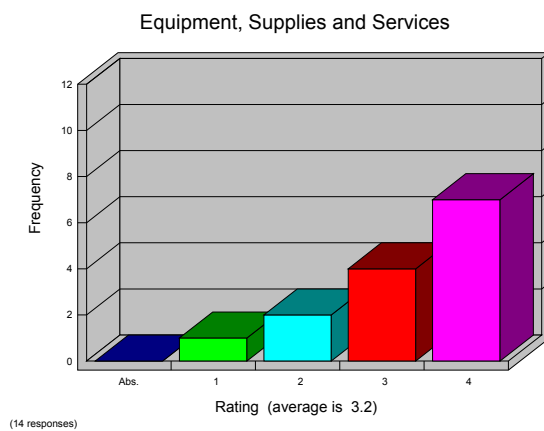


Figure 9: Assessment of NEOps Impact on Equipment, Supplies and Services

This paper will next address how the Canada has sought to further their understanding of and advance the development of NEOps.



## **EXERCISE ROBUST RAM AND OP GRIZZLY**

The Canadian Forces Experimentation Centre (CFEC) has been at the forefront of efforts to explore NEOps within the Canadian context and has used a spiral development approach, involving a series of progressively more demanding experiments, to examine the benefits of providing sensors output from a Uninhabited Aerial Vehicle (UAV) to an Integrated Intelligence Surveillance and Reconnaissance Architecture (IISRA). Specific focus is on feeding results from electro-optical and infrared imagery and radar data to a network-centric, distributed environment, connecting commanders, operators, sensors and weapons systems across tactical, operational and strategic boundaries, leading to the right information reaching the right person at the right time. In order to achieve this, information has to be acquired, communicated, analyzed, shared and acted upon in a timely manner to be of value. The explicit purpose of applying such network-centric practices is to provide improved, timely situational awareness, thereby improving command and control practices, and enhancing force effectiveness.

The first NEOps experiment took place associated with Exercise Robust Ram during April 2002 in Suffield, Alberta. Experiment goals included Medium Altitude Long Endurance (MALE) UAV operations within a Joint Task Force, Vertical Take-Off UAV (VTUAV) operations, Mini UAV operations, UAV integration into the Canadian Forces Command and Control System, UAV airspace and airworthiness validation, education of Canadian Forces personnel, and data collection for scientific analysis. The UAVs used were the General Atomics-ASI I-Gnat, the Bombardier Guardian, and the AeroVironment Pointer.

The experiment began with the linking of the Mini UAV, the Pointer, with a Coyote Reconnaissance Patrol. Although an infrared camera is available for the Pointer, only a daylight camera was available during the experiment period, thereby limiting the usefulness of the system. Nonetheless, over a period of seven days, 39 Pointer flights occurred, totalling 15.85 hours flight time with an average turnaround time of less than three minutes. The UAV operated at a maximum distance of 9.9 kilometres and had an average operating range of 5 kilometres. Due to issues with the frequency spectrum and airspace integration, the Mini UAV never operated at higher than 500 feet above ground level.<sup>13</sup>

An immediate result of this Mini UAV pairing with the reconnaissance function was an enhanced range and situational awareness for the patrol. For example, a patrol member noted that “Since the Recce Patrol only [has] the ability to view the horizontal plane, they often cannot determine [the] depth or size of the position, especially dominating ground, or rear slope position. Pointer UAV would provide the ability to gain this vital information.”<sup>14</sup>

---

<sup>13</sup> Lieutenant Colonel S.J. Newton et al, Canadian Forces Experimentation Centre Experiment Report IICDE – 001/2002 (Interim), Uninhabited Aerial Vehicle Concept Development and Experimentation, 1 August 2003, p. vi.

<sup>14</sup> Ibid.

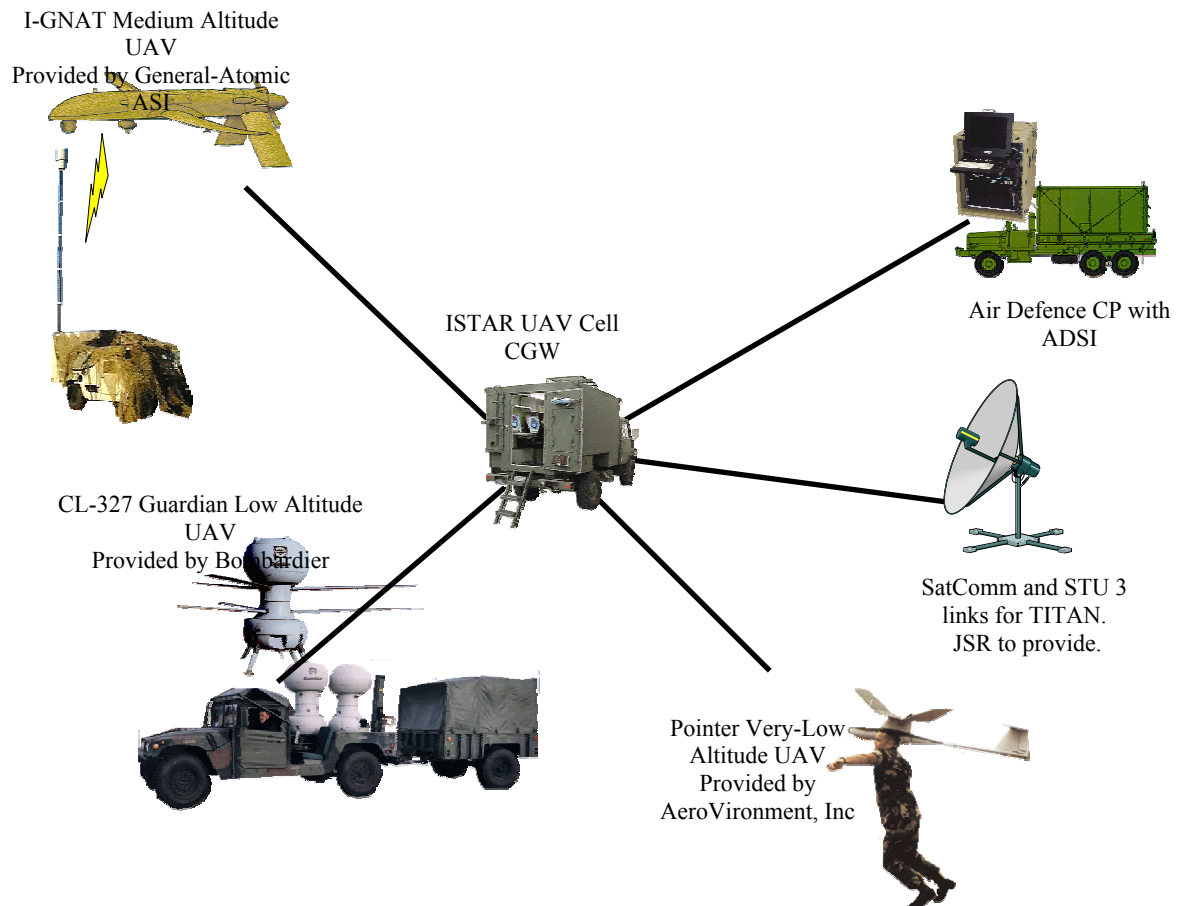


Figure 10: High-Level Robust Ram UAV Architecture

The Vertical Takeoff UAV used during Robust Ram, Bombardier's Guardian, was integrated with a CDL Systems ground control station, and this provided an effective, field deployable and highly manoeuvrable Brigade-level asset. Fitted with electro-optical and infrared sensors, the Guardian flew seven missions over 15.3 hours at altitudes between 5,000-10,000 feet above sea level, with an average turnaround time of about 2.5 hours.

Operating as a MALE theatre-level asset, General Atomics' I-Gnat flew seven missions over 29.41 hours. It operated at a ceiling of 15,000 feet above sea level due to flight restrictions. The I-Gnat was equipped with WESCAM's 14QS electro-optical and infrared sensors or the Lynx Synthetic Aperture Radar. While the I-Gnat provided effective ISR coverage of the exercise area, the imagery metadata needed to cross-reference targets for situational awareness and scientific analysis was not available since

software required for this was not loaded on the ground control station.<sup>15</sup> Difficulties with the digital data link and the lack of spectrum clearance from Industry Canada also prevented effective use of the Ground Moving Target Indicator and Coherent Change Detection capabilities of the Lynx SAR. Notwithstanding these problems, all operational experiment objectives were met, although the absence of imagery metadata impaired the more comprehensive scientific data collection objectives and reduced the potential quality of situational awareness.<sup>16</sup>

As part of Exercise Robust Ram, optimal network configuration was not achieved due to a compressed schedule that prevented wide-ranging rehearsal and systems integration testing. However, the continuously evolving architecture certainly benefited from the experience obtained during the experiment, and the hard work and dedication of technicians.<sup>17</sup> The mini UAV proved relatively easy to integrate into the architecture, with Pointer video feed being transmitted up to eight kilometres to higher headquarters from the Coyote Reconnaissance Patrol via a Near Term Digital Radio (NTDR). The transfer of data beyond this distance was achieved either directly via a line of sight SC-6 microwave link or relayed via the NTDR to the SC-6 microwave link for onward transmission to the headquarters.<sup>18</sup> The Vertical Takeoff UAV, the Guardian, was also relatively simple to integrate into the command structure due to the Guardian's Ground Control Station being collocated with brigade headquarters. Telemetry data and video was sent from the Ground Control Station to a Remote Video Terminal (RVT) via a fibre-optic connection. The RVT then used an Ethernet connection to the headquarters' local area network to post near real time video and situation display. Consequently, Explorer or Netscape was used to access the video stream, which was available across Canada through a TCP/IP network. The General Atomics I-Gnat proved to pose the greatest integration challenges. In the first place, there was the distance involved between the Ground Control Station and the Brigade Headquarters. To address this, a Canadian Marconi Company (CMC) High Capacity Line of Site (HCLOS) microwave data link was set-up for the 25-kilometre distance between the Suffield airfield and the experimentation headquarters. While an 8 Mbps rate was expected, this data link rarely achieved transmission bandwidths above 1.5 Mbps and never exceeded 2.5 Mbps. While military technicians were able to adjust the digitisation parameters at the ground control station to cut data latency to about four minutes, the reduced bandwidth would allow only 25% resolution imagery to be transmitted. Notwithstanding this, the imagery received at brigade headquarters was sufficient to clearly identify personnel at an altitude of 15,000 feet and a slant range of 13 kilometres using the WESCAM EO/IR payload. Investigation subsequent to the experiment revealed that this reduced functionality could have been avoided through a different configuration of the CMC HCOL data link.<sup>19</sup>

As noted earlier, the integration of UAV data into the command and control system was a stated goal of the experiment. The network centric techniques developed as part of Robust Ram included feeding the data from the three UAV platforms into the

---

<sup>15</sup> Ibid., p. vii.

<sup>16</sup> Ibid.

<sup>17</sup> Ibid.

<sup>18</sup> Ibid., p. viii.

<sup>19</sup> Ibid., pp. viii-ix.

GCCS-I3 Imagery server for onward transmission across the Intelligence, Surveillance and Reconnaissance (ISR) HQ on a ruggedised PC LAN. As part of this, an ISR commander concept was used, which mixed command and staff functions into a single entity responsible for the ISR function. The single ISR network was viewed as an “all source cell”, combining the command and control functions of all ISR systems, resulting in improved situational awareness and force effectiveness. However, the Tactics, Techniques and Procedures (TTP) used to delegate responsibility and tasking authority proved to need further development. In fact, the Command and Control process for the UAVs evolved incrementally throughout the experiment.<sup>20</sup>

The absence of the embedded metadata from the I-Gnat caused by the missing software and the resulting unavailable telemetry impaired the level of situational awareness achievable during the experiment. Moreover, it was noted that the metadata standards for the three UAVs were different from one another; in fact, none of the metadata standards used by the UAVs complied with any accepted coalition standard. It became quite obvious that command standards for imagery storage and archiving, data links and metadata are critical for payload data fusion and integration, and for coalition operations of the future.<sup>21</sup>

Notwithstanding these issues, a preliminary Automated Target Recognition/Geo-location study of the 60 hours of imagery collected by the various UAVs indicates that situational awareness improved significantly during Robust Ram. Based solely upon the EO/IR imagery, this study indicates that there was a 90% probability of target recognition for images with a National Image Interpretability Rating Scale rating of 6-8.<sup>22</sup> Based upon a limited sample of Pointer-generated images, geo-location accuracy was approximately 12 metres rms (root mean squared). In order to further enhance force effectiveness, development work is focusing on automating the detection, classification and geo-location processes using networked communications across IISRA components.<sup>23</sup>

From a human resource perspective, while the complexity and operator skill sets needed for the three UAVs varied, it was concluded that the required skill sets already exist within the current Canadian Forces occupational structure. Further study will confirm these skill sets and help develop personnel levels for any future operational UAV unit. As part of the experiment, the roles of Mission Commander and UAV Liaison Officer were identified to address current communications and technology deficiencies.<sup>24</sup>

As a result of the increased force effectiveness realized during Robust Ram, the Commander, 1 Canadian Mechanized Brigade Group, advocated the use of the I-Gnat MALE and Pointer mini UAVs during the forthcoming OP GRIZZLY, which was in support of the G8 Summit at Kananaskis, Alberta, 25-27 June 2002. Equipment availability resulted in just the I-Gnat being deployed.

---

<sup>20</sup> Ibid., p. ix.

<sup>21</sup> Ibid.

<sup>22</sup> Ibid.

<sup>23</sup> Ibid., p. x.

<sup>24</sup> Ibid.

Since OP GRIZZLY was a real-time operation vice an experiment, the ability to develop and satisfy experimental objectives was limited. A 30 x 35 nautical mile operating box was established around Kananaskis for the I-Gnat and a Joint Airspace Coordination Centre was responsible for integrating the I-Gnat with other airspace users. Operational requirements resulted in the WESCAM 14QS EO/IR payload being used primarily, with the Lynx Synthetic Aperture Radar available in the event of poor visibility. Good weather conditions resulted in the EO/IR payload being used exclusively.

The Joint Force Land Component Commander effectively used the I-Gnat as a operational level asset during OP GRIZZLY. In addition to using infrared as the main target detection device, the electro-optical function was used for recognition, identification and situation awareness. As it turned out, the I-Gnat was critical to the detection of a low and slow flying aircraft within the patrol area that had been missed by AWACS. The data link connectivity problems encountered during Robust Ram was avoided through the lease of a 6 Mbps hardwire connection between the UAV detachment and the ISR HQ. Accordingly, full metadata was available to enhance situational awareness and facilitate imagery exploitation.<sup>25</sup> The utility of the UAV during this operation was such that the Assistant Chief of Defence Staff formally recommended “further concept development and experimentation for the use of UAVs to support Task Force Commanders and other government departments in domestic operations should be pursued.”<sup>26</sup>

### **PACIFIC LITTORAL ISR EXPERIMENT (PLIX)**

Following up on the successes of Robust Ram and OP GRIZZLY, an ISR experiment was scheduled for 8-13 July 2003 off the west coast of Vancouver Island. The experiment used commercial off-the-shelf technology to achieve a rapid prototype as part of an IISRA to help address identified information and intelligence capability deficiencies. The resulting experiment, Plix, sought to develop an experimental recognized maritime picture (XRMP), which would be supported by a UAV, to detect, track and positively identify targets within a defined geographic area, in comparison to the effectiveness of an existing recognized maritime picture (RMP). Once again, a line of sight Medium Altitude Long Endurance (MALE) UAV was used.

Israeli Aircraft Industries (IAI) won the contract for Plix UAV support. The IAI Eagle 1 was used, which has an operational altitude of 20,000 feet, maximum airspeed of 120 knots and a cruising speed of 80-110 knots. It was outfitted with a TAMAM Multi-mission Optronic Stabilized Payload (MOSP) electro-optical and infrared sensor, and an ELTA 2022-A(V3) maritime patrol radar.<sup>27</sup> Four flights, with a total of 19.43 hours flight time, were made during the experiment.

---

<sup>25</sup> Ibid., p. xi.

<sup>26</sup> Ibid., pp. xi-xii.

<sup>27</sup> Lieutenant Colonel S.J. Newton et al, Experiment Report 001/2003 (Quick Look), Pacific Littoral ISR Experiment – Part 1, 28 August 2003, p. 1.

Supporting infrastructure for the UAV was setup at the Tofino airport, located on the western coast of Vancouver Island, and the IISRA for exploiting the data was located at the main Canadian naval establishment on the west coast, Esquimalt, which is located at the southeast portion of Vancouver Island. Although high-speed connectivity was anticipated between the two sites, only two 56 kbps lines were available at the time of the experiment (Figure 11 refers). Tactical level support for the experiment was located at Tofino and operational level support was at Esquimalt, where one command team had access to existing ISR assets to develop a RMP and a second team had the added benefit of access to the UAV data to develop a XRMP. Strategic level support was provided by an analyst located in Ottawa at the National Defence Command Centre, where there was access to the ISR contact information and imagery.<sup>28</sup>

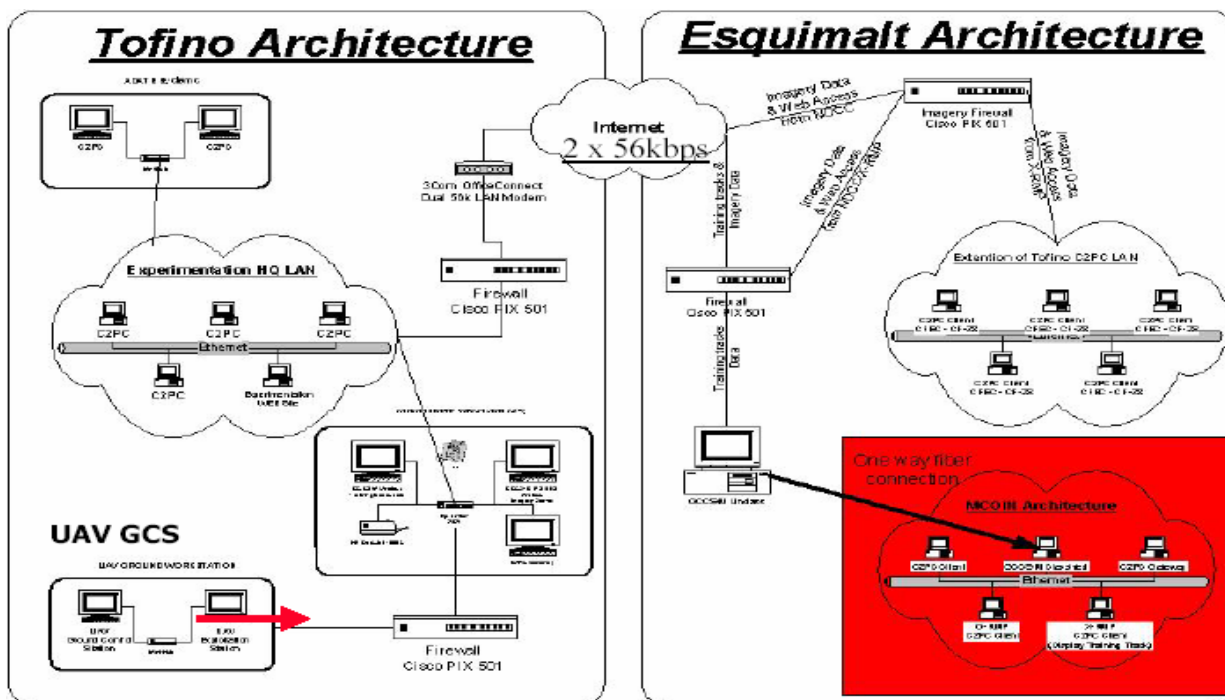


Figure 11: PLIX Architecture

The experiment was conducted using the hypothesis that:

“If a UAV patrols a designated operations area of littoral waters, then all surface contacts are detected, continuously tracked, and positively identified in the experimental RMP of the operations area before the end of the patrol.”<sup>29</sup>

This hypothesis was falsified during each of the four flights conducted during the experiment, since all surface contacts could not be identified or classified in the XRMP before completion of the patrol. However, for the reasons to be discussed below, PLIX

<sup>28</sup> Ibid.

<sup>29</sup> Ibid., p. 2.

was considered a success because it effectively tested the hypothesis and the useful lessons learned on the development of enhanced force effectiveness in the future.

While PLIX results were affected by weather, system architecture and the relative inexperience of military personnel, it is evident that the addition of the UAV significantly enhanced the quality of the XRMP over that of the RMP. Specifically, upon deployment, the UAV immediately identified multiple contacts within the target area, significantly improving the quality and timeliness of this information for the XRMP over the RMP. Additionally, there were no false contacts identified for the XRMP, although further investigation with the UAV payload devices proved that some contacts were simply flotsam. Moreover, the contract tracking function between the UAV and Ground Control Station was found to be effective, although the automatic reporting format used to enter this data on the command and control system in Esquimalt limited the accuracy of contact location to one nautical mile. Given the apparent performance characteristics of the UAV payload, this accuracy could have been reduced to 20 metres if not for the limitations of the current RMP architecture. This shortcoming of the automatic reporting system meant that contact information from the UAV could be reported every three minutes, instead of the initial practice of reporting such information every minute, without reducing the quality of the situation awareness, since targets could not move fast enough within that period to move more than one nautical mile from a reported location.<sup>30</sup>

Initially there was no means of classifying targets located by the UAV; however, operators quickly found that the Inverted Synthetic Aperture Radar (ISAR) and EO capabilities of the UAV could be used effectively to eliminate targets larger or smaller than any vessel of interest. Vessel identification was complicated by flight altitude restrictions, but whenever weather conditions permitted the UAV's EO sensor could be used to image a vessel's nameplate. This process was enhanced with the addition of information found within the existing RMP, including shipping databases, position reports and a vessel traffic management system.<sup>31</sup>

It was also found that the XRMP could monitor and track new information better than the existing RMP due to the time and effort required to input and update vessel classification and identification information.<sup>32</sup> Furthermore, the command team working with the XRMP used fewer assets to resolve assigned problems and appeared more confident in their solutions. This implies enhanced force effectiveness with reduced resources over current capabilities through the use of network-enabled operations.

Human Factors observations during PLIX were consistent with those from Robust Ram and OP GRIZZLY – Canadian Forces personnel have the required skills to operate a UAV and to post relevant data on command and control systems in order to improve situation awareness and improve force effectiveness. However, it was also noted that the selection, training and employment of personnel needed to ensure personnel develop the ability to operate within an air environment, to increase spatial awareness, and to have the ability to think in three-dimensions. Familiarity with the function of the command and

---

<sup>30</sup> Ibid., pp. 7-8.

<sup>31</sup> Ibid., p. 7.

<sup>32</sup> Ibid., p. 8.

control systems was an issue for some personnel, which could have been addressed with further training. Additionally, it was observed that the design, implementation and maintenance of communications systems, information technology and information management infrastructure needed to better address the transmission and fusing of sensor data.<sup>33</sup>

Interestingly, a real-world incident intruded on PLIX. During the course of one flight, a ship was observed polluting the ocean. The UAV video of this action has since been used as part of a Transport Canada investigation.

PLIX also demonstrated a number of things in relation to infrastructure and organization. In the first place, it was found that the location of the UAV line-of-sight Ground Data Terminal drove the layout for the rest of the supporting infrastructure. It also became evident that a UAV Flight Operations Section requires mission planning, meteorological, intelligence, and command and control support.<sup>34</sup>

A number of lessons were learned in relation to concepts, doctrine and collective training. With the inclusion of a UAV, the XRMP provided persistent surveillance capability, thereby contributing to better situational awareness, and enhanced force effectiveness. This would be further improved with better all-weather performance, a more comprehensive contact database to support information exploitation, and enhanced beyond line-of-sight capabilities than were available for the UAV during this experiment.<sup>35</sup>

As part of information management, PLIX confirmed the Robust Ram lesson that standard imagery formats are required. It also reinforced that effective two-way data exchanged is critical as part of an IISRA. Additionally, it demonstrated that the information infrastructure itself must have sufficient bandwidth to allow for distributed collaborative planning.<sup>36</sup>

Finally, a number of lessons were learned in relation to information and equipment requirements, and doctrine. For example, sensors must be capable of all-weather performance and a more comprehensive contact database is required to support information exploitation. PLIX also demonstrated that it was possible to integrate a UAV into an uncontrolled airport and into domestic airspace in conjunction with Transport Canada procedures and NOTAMS.<sup>37</sup>

### **ATLANTIC LITTORAL ISR EXPERIMENT (ALIX)**

As the final experiment in this series, during August 2004, CFEC will be conducting a series of ISR experiments off the Canadian east coast as part of ALIX, the aim of which is to integrate and exploit multiple sensors into an integrated ISR

---

<sup>33</sup> Ibid.

<sup>34</sup> Ibid., pp. 11-13.

<sup>35</sup> Ibid.

<sup>36</sup> Ibid.

<sup>37</sup> Ibid.



architecture, including an assessment of UAV employment. Objectives of the experiment include seeking to understand MALE UAV beyond line of sight requirements for Canadian Forces employment and acquisition, to understand IISRA requirements required for increased force effectiveness, and to explore and understand the tenets of NEOps. For the purposes of ALIX, the General Atomics-ASI Altair (which is an extended range version of the Predator B) will be used. Moreover, as part of this experiment, the utility and effectiveness of the Task, Post, Process, and Utilize (TPPU) process will be evaluated. Specific critical operational issues to be explored include the examining the effectiveness of multi-source, multi-sensor data fusion within an IISRA, the timeliness of information flow within this environment, the relative effectiveness of sequential and parallel data exploitation, how effective information reach and sharing is within this architecture, and the relevance, completeness and responsiveness of the IISRA to decision-making.

ALIX will consist of three missions based upon approved force planning scenarios. During this experiment, the UAV will be launched and recovered at Goose Bay, Newfoundland. Once airborne, control will be switched to a remote operations centre in Ottawa. The first scenario will include a domestic operation involving a simulated satellite crash in the Canadian Arctic near Pangnirtung, Baffin Island, during which support will be provided to an on-site Joint Force Commander (JFC). The second scenario entails a peace support operation in Gagetown, New Brunswick, involving target acquisition, surveillance and reconnaissance, and battle damage assessment support to the JFC. Finally, the third scenario concerns a simulated seaborne terrorist attack on an international conference in St John's, Newfoundland from the area of the Grand Banks.

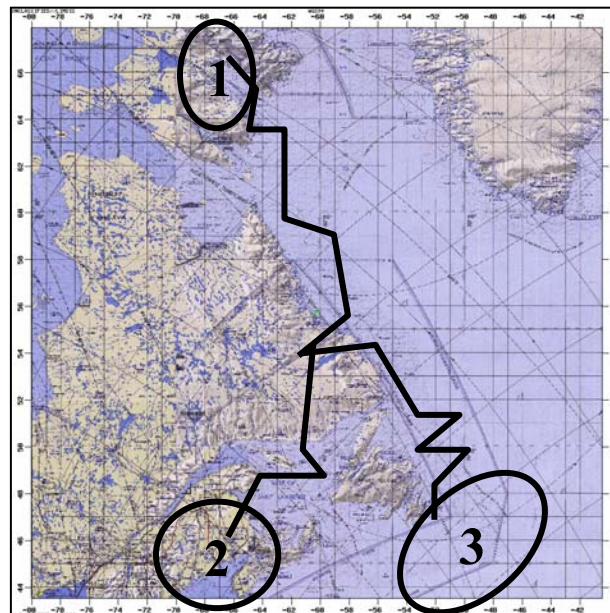


Figure 12: ALIX Scenarios

The current working hypothesis for ALIX is:

If multiple distributed sensors, weapons systems, and decision makers operate as elements of the IISRA and TTPU is used, then force effectiveness increases.

The results from this forthcoming experiment will be reported upon at a later time.

## **THE ROAD AHEAD**

Canada continues to explore the concept of NEOps. As part of this, a high level symposium has been proposed for the late Fall of 2004, which, in conjunction with the soon to be released Canadian Forces Strategic Operation Concept, is intended to lead to the formal adoption of NEOps as a vehicle for transformation within the military. Included as part of this symposium will be the development of a departmental roadmap that would identify specific roles, responsibilities and implications for the army, navy and air force, as well as the articulation of a strategy for the further development and acquisition of NEOps capabilities, and the personnel selection, training and education ramifications. In addition to this, CFEC, various Defence Research and Development Canada centres, and a range of defence headquarters, army, navy and air force representatives remain focused on developing and investigating Network Enabled Operations.

## **CONCLUSION**

In conclusion, there is a realization within Canada that NEOps must become an integral component of force transformation. Accordingly, NEOps is anticipated to be one of two integrating concepts for the forthcoming capstone Canadian Forces Strategic Operation Concept. In support of this, a wide range of initiatives has and continues to occur. This includes policy and doctrine articulation, research and development, concept development and experimentation. In view of this, NEOps may reasonably be viewed as having taken a firm foothold in the Canadian military.



# Network Enabled Operations in the Canadian Context

Briefing  
to  
9<sup>th</sup> Command and Control Research and  
Technology Symposium

By  
Sandy Babcock

15-17 Jun 04



# OUTLINE

- 1) Canadian Initiatives to date
- 2) Robust Ram
- 3) Pacific Littoral ISR Experiment
- 4) Atlantic Littoral ISR Experiment
- 5) The Way Forward



# CANADIAN NEOps INITIATIVES



- **C4ISR Campaign Plan**
- **Canadian Forces Experimentation Centre**
- **International Fora (NATO WGs – e.g. ET 049, TTCP – e.g. NCW AG)**
- **Bilateral Cooperation/Liaison (Australia, UK, USJFCOM) (e.g. MAR AG 1 and AG 10)**
- **Individual Contributions**



# CFEC INITIATIVES

- Concept Development (NEOps, EBO, ACAR, Alternative Futures)
- UAV-related Experiments
- Series of Workshops
- Gap Analysis
- PRICIE Assessment (DOTMILTP)
- Co-sponsorship of departmental NEOps symposium 30 Nov – 2 Dec 04



# CFEC Thrust Areas

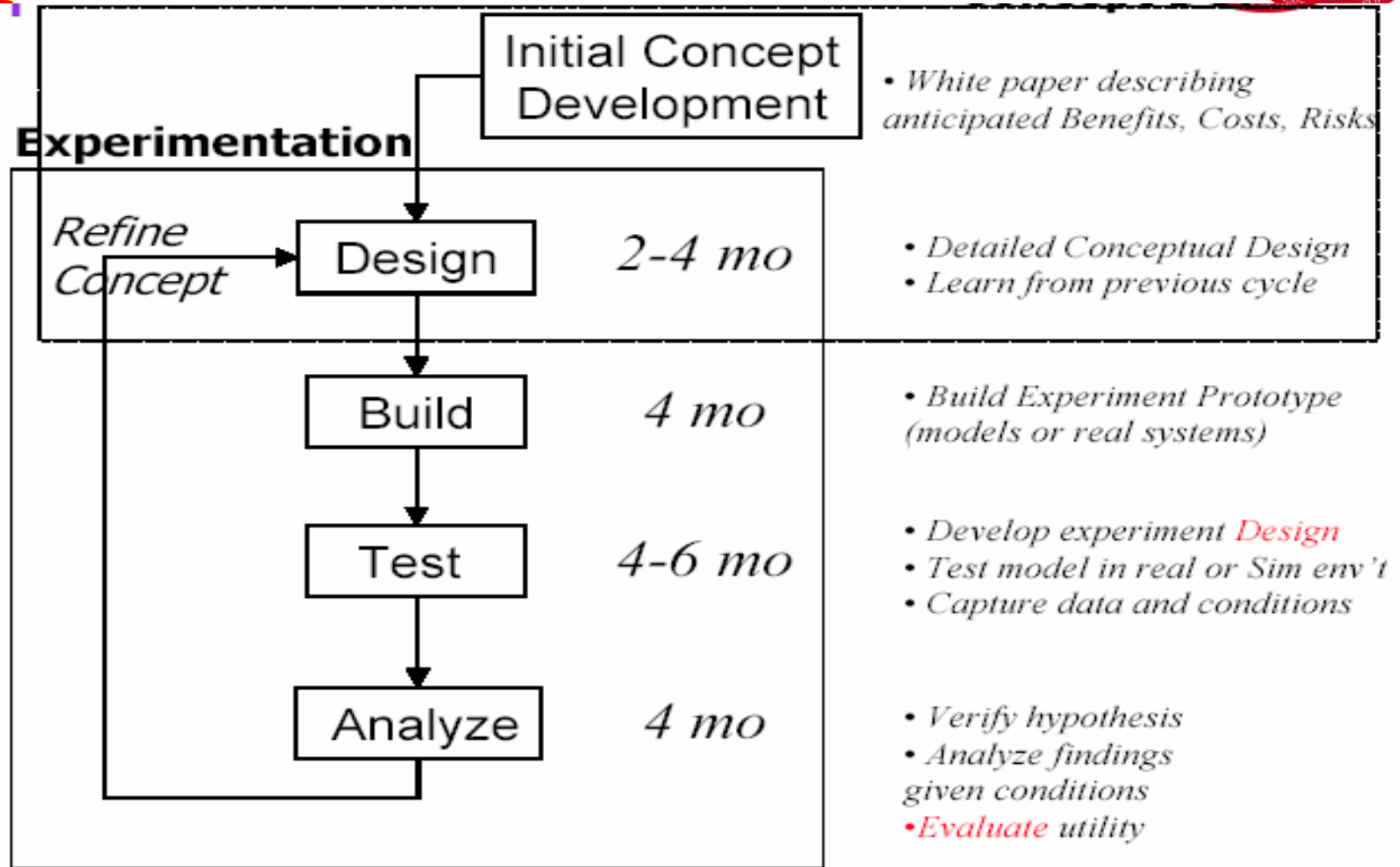


	INTEGRATING CONCEPT	FUNCTIONAL CONCEPT	EMPLOYMENT CONCEPT
CAPSTONE CONCEPT STRAT 2020	COMMAND & CONTROL	<u><b>EFFECTS BASED OPS</b></u>	POL-MIL
			<u><b>COLLABORATIVE PLNG</b></u>
			<u><b>JOINT TARGETTING</b></u>
		<u><b>COLLABROATIVE INFORMATION ENVIRONMENT</b></u>	<u><b>COP 21</b></u>
			<u><b>FUTURE CFCS</b></u>
			COMBAT ID
	INFO & INTEL	<u><b>INTEGRATED ISR ARCHITECTURE</b></u>	<u><b>UAVs</b></u>
			<u><b>IISRA</b></u>
			C2 ISR SYSTEMS
		EFFECTS BASED ASSESSMENT	RED TEAM
			GLOBAL INFO GRID
	<u><b>SUSTAIN</b></u>	LOGISTICS INFO FUSION	KNOWLEDGE MGMT
			<u><b>COMMON LOGISTICS PICTURE</b></u>
			<u><b>LOGISTICS DECISION SUPPORT</b></u>
		JOINT AND COMBINED LOGISTICS INTER-OPERABILITY	LOGISTICS PLANNING AND EXECUTION
			ALLIANCE/COALITION LOGISTICS
			<u><b>INTEROPERABILITY WITH OGDS/NGOS/ CONTRACTORS</b></u>
			CF JOINT LOGISTICS

PLIX  
ALIX



# Experimentation and Concept Maturation Process







## Exercise ROBUST RAM

- Experiment conducted in Apr 02 exploring employment of UAVs as an ISR platform within a network-centric environment.
- Used three UAV platforms (Guardian – Bombardier, I-Gnat – General Atomics-ASI, Pointer - AeroVironment) teamed with a Coyote Reconnaissance Vehicle.
- Experiment conducted in Suffield, Alberta.
- Subsequently used I-Gnat in support of Op Grizzly, support for G-8 Meeting in Kananaskis, Alberta, in Jun 02.



# ROBUST RAM RESULTS

- Canadian Forces occupational structure has all the necessary skill sets to operate and exploit the technological and information advantages offered by UAVs.
- A family of UAVs is required to provide seamless coverage of the battle space.
- UAVs cannot be considered in isolation; must be integrated into an integrated ISR architecture
- Recommend acquisition of proven and mature UAV system for integration into the Coyote Reconnaissance Vehicle.
- Need to further test concept, using medium altitude long endurance (MALE) UAV.



# Pacific Littoral Experiment (PLIX)



## Background

- The Canadian Forces have identified an Information and Intelligence (I2) capability deficiency
- Commercial off the shelf (COTS) technology using Integrated ISR Architecture hardware/software plus UAVs and sensor suite.
- Purpose of Experiment: to observe the I2 capability delivered by the ***operation*** of particular configuration of COTS technology as a rapid prototype.
- Conducted 8-13 Jul 03 at Tofino and Esquimalt, British Columbia.



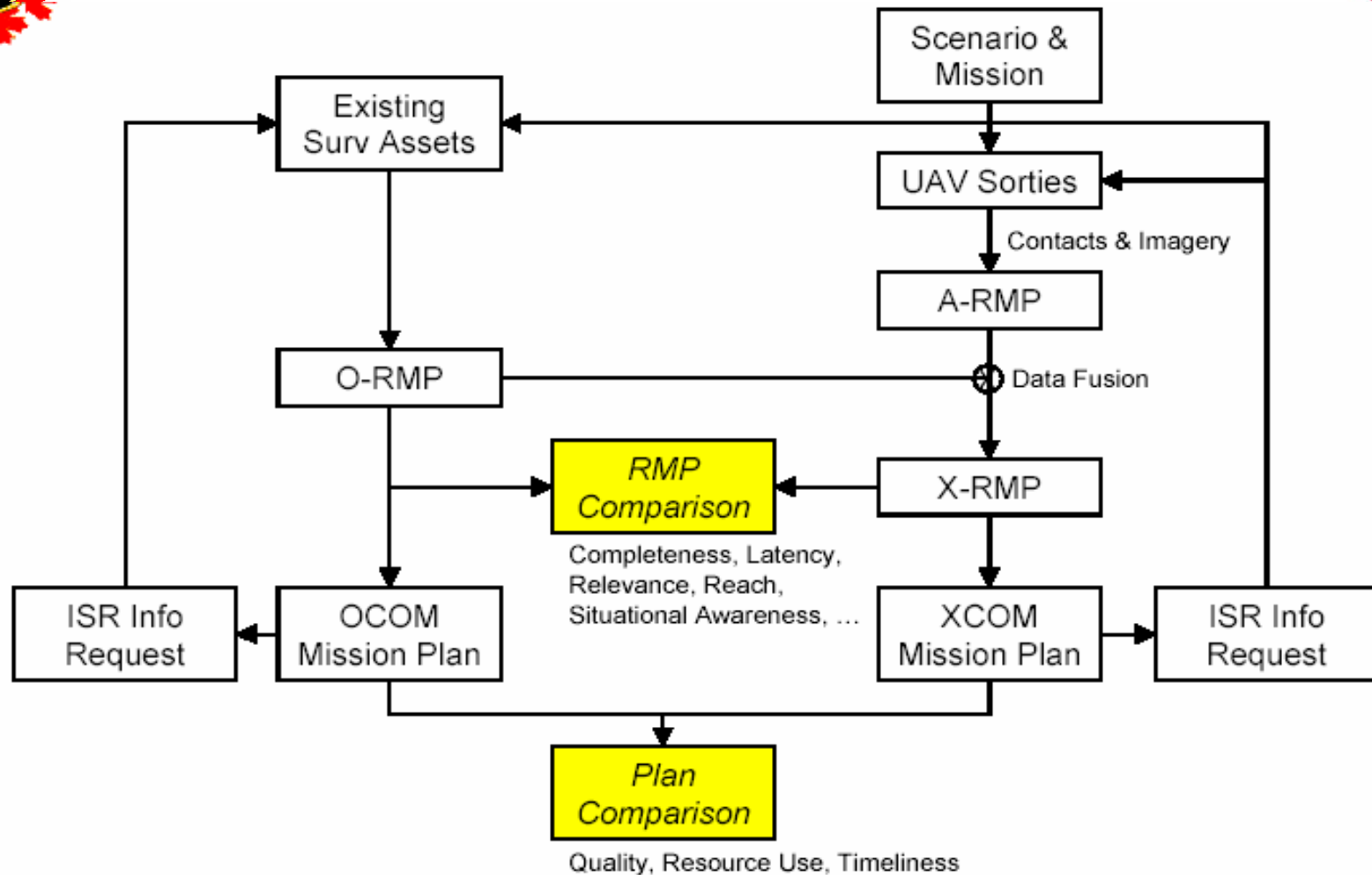
# PLIX Hypothesis



- If Plix UAV patrols a designated littoral operations area, then all surface contacts are detected, continuously tracked, and positively identified in the experimentation recognized maritime picture (XRMP).
  - NOTE: This was the proposition to test, not a promise to keep – it was clearly falsifiable and was framed in consultation with the sponsor

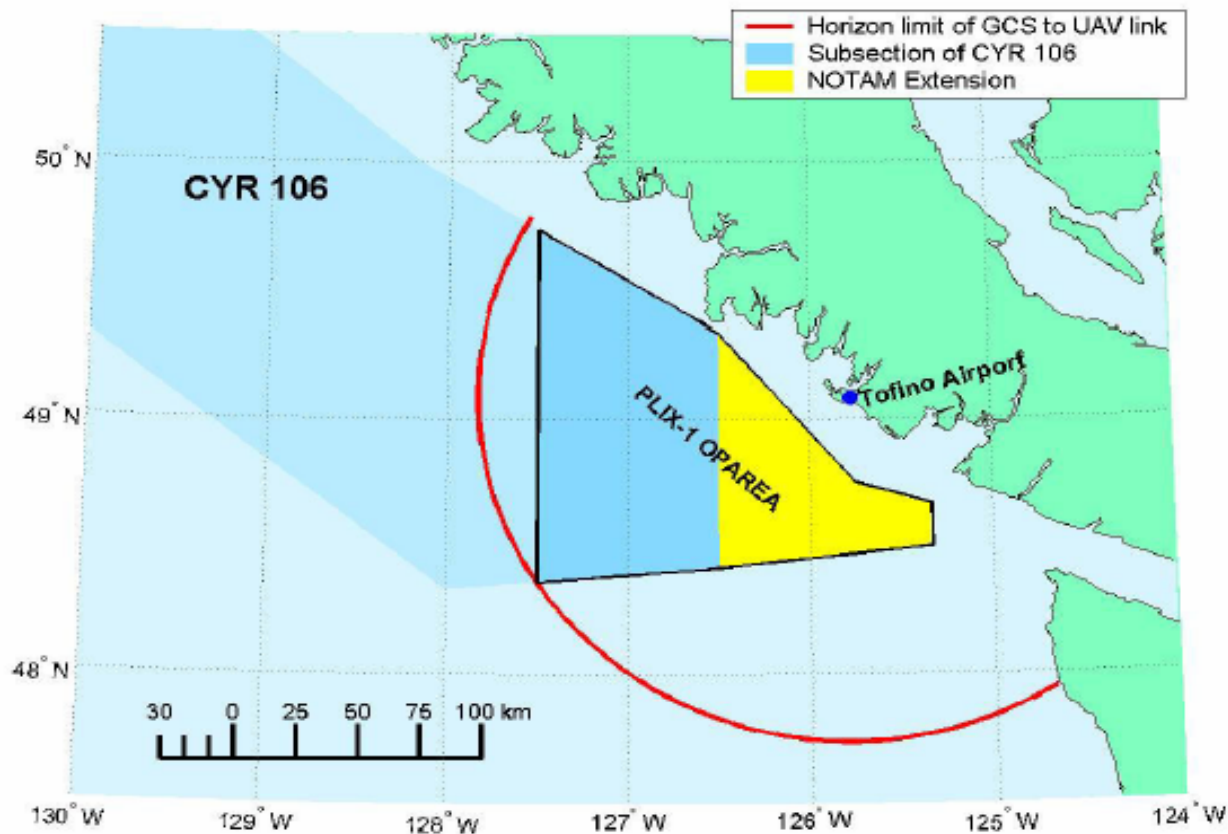


# Design Schematic





# Operations Area





# PLIX UAV – IAI Eagle I

- Operational Altitude (OA): 20,000 ft
- Max. air speed: 120 Knots
- Cruise speed at OA: 80 to 110 Knots
- Mission Time: 30 hours
- Sensors: EO/IR, MPR
- Manufacturer's MPR Specified Detection Ranges
  - Dinghy 11 nm
  - Fast Patrol Boat 27 nm
  - Tanker/Corvette 65 nm







# Participating Naval Units



CCGS BARTLETT



CCGS GORDON REID



CCGS SIR WILFRID LAURIEF



CCGS TANU



**Position recording every 6 minutes during experiment period.**



**Position recording every 6 minutes  
Following scripted event profiles.**



YARD PATROL CRAFT AGATE PASSAGE YP 697

Raytheon 1488 G

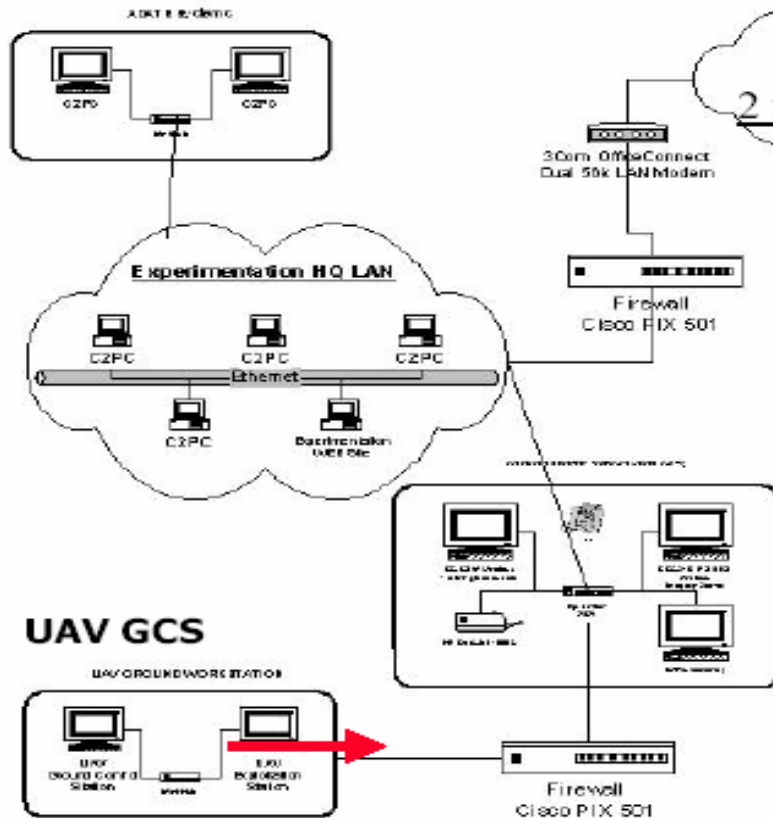
**YP 697 Agate Passage**  
**Coastal Oiler**  
**Ship in Distress**  
**Immigrant Smuggler**  
**Terrorist Vessel**



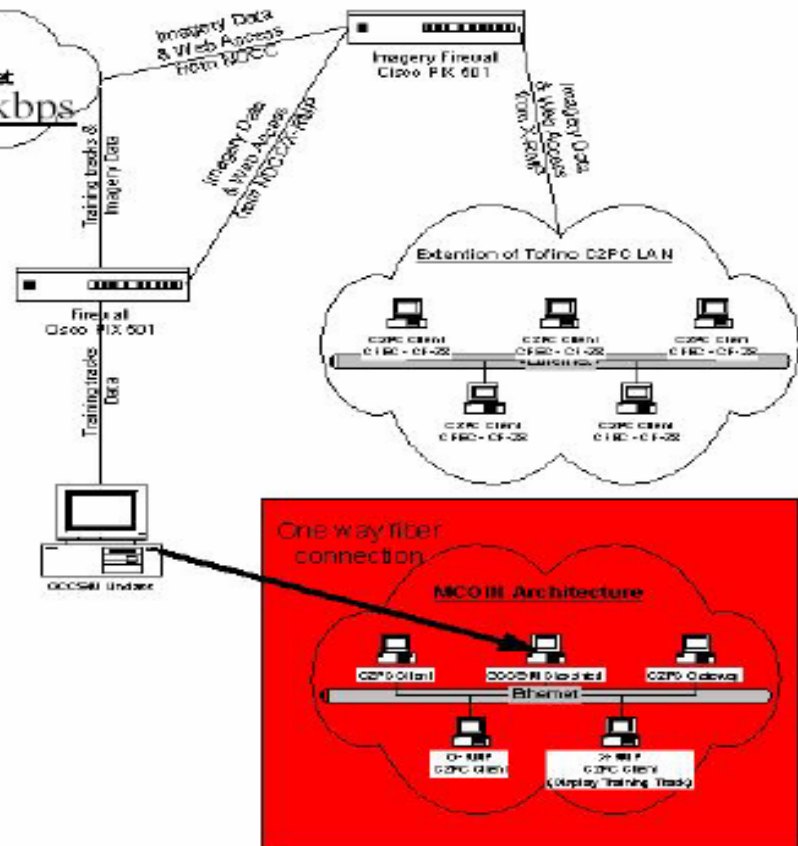


# PLIX Network Architecture

## Tofino Architecture



## Esquimalt Architecture





## Issues (Preliminary)



- Intrusion of “real world” incident.
- Bandwidth available between Tofino and Esquimalt introduced latency issues, resulting in false Postings (TPPU). Latency also influenced by personnel factors, hardware and software limitations, and inadequate procedures for NCO environment.
- UAV icing.
- UAV radar had mixed success detecting and tracking targets.

**Net Result:** Hypothesis was falsified.



## Lessons Learned

- **P**ersonnel
- **R**esearch and Development / OR
- **I**nfrastructure and organization
- **C**oncepts, doctrine and collective training
- **I**nformation management
- **E**quipment, supplies and services



# Questions



## **P**RICIE

- Sensor Ops: air sense and 3D awareness required
- Wide variability in GCCS knowledge

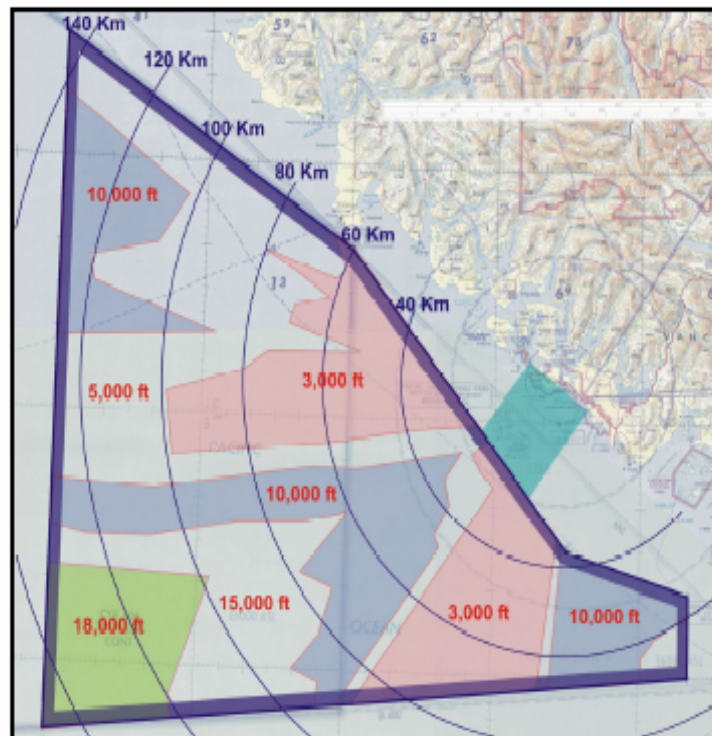
## **P****R**ICIE

- Baseline surveillance assessment required to understand RMP quality and accuracy of inputs
- Req't for all weather classification/identification capability
- Req't for Beyond Line of Sight Capability



# UAV Line of Sight

- MALE UAV operations limited by line of sight datalink impacting on contact classification and identification



Minimum UAV LOS Operating Altitude (feet)



## Lessons Learned (Cont'd)

### PR**I**CIE

- Ground Data Terminal (GDT) location drives infrastructure layout
- Flt Ops support needs include mission planning, meteo, intel, C4 systems

### PR**I**CIE

- UAV contributed significantly to RMP
- need for all weather sensor performance
- UAV airspace integration completed with Transport Canada procedures and NOTAMS



## Lessons Learned (Cont'd)

### PRI**C**IE (Cont'd)

- Require Multiplexed sensor suite
- Reference contact database needed for info exploitation
- UAVs provide persistent surveillance capability
- line of sight datalink impaired classification and identification

### PRIC**I**E

- Require bandwidth for distributed collaborative planning
- Adopt NATO STANAG formats for imagery
- Need effective 2-way data exchange in IISRA
- Fully test IISRA and procedures in ALIX



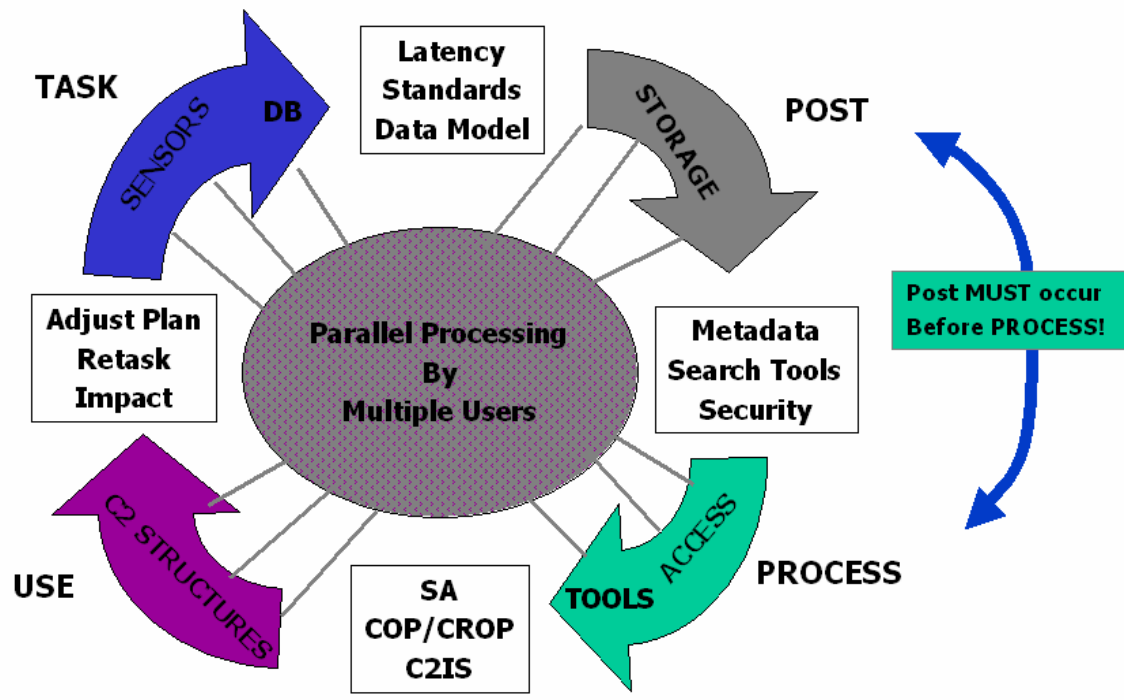
# Atlantic Littoral Experiment (ALIX)

- Scheduled 16-31 Aug 04
- Intended to examine ISR Critical Operational Issues, including:
  - Effectiveness of multi-source, multi-sensor data fusion practice using IISRA
  - Timeliness of information flow (latency)
  - Exploitation (sequential and parallel TPPU)
  - Information Reach/Sharing
  - Relevance, completeness and responsiveness to decision-making



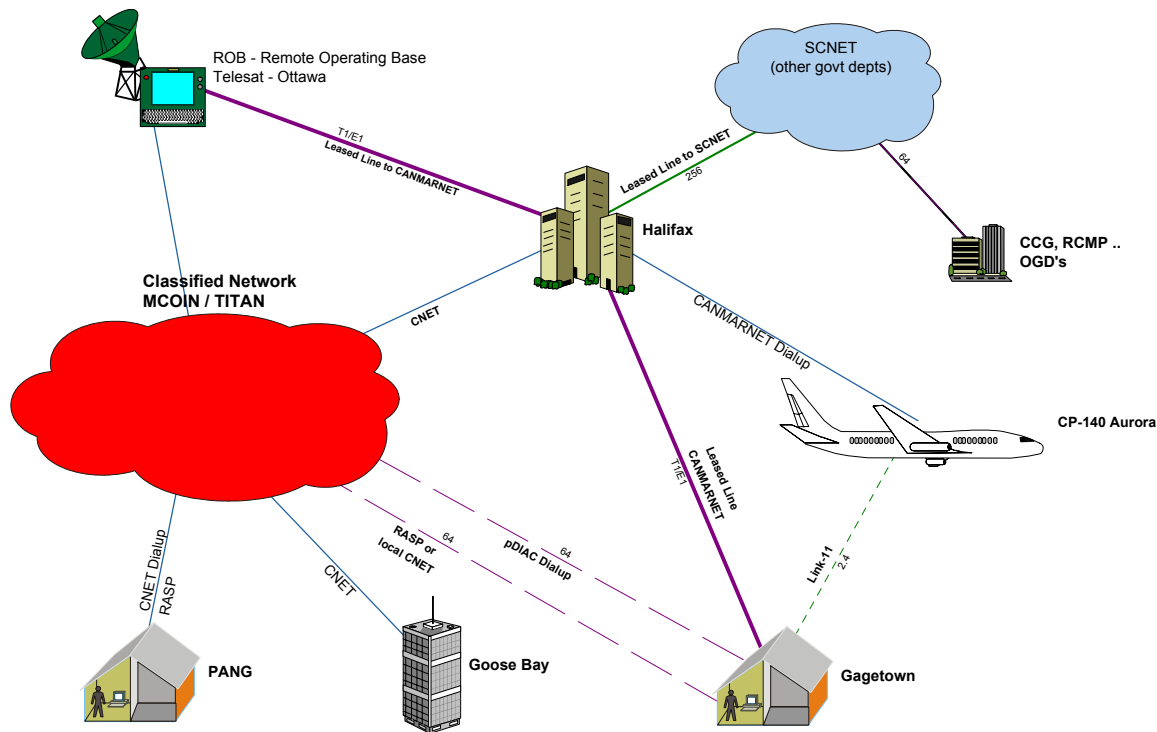


# TPPU





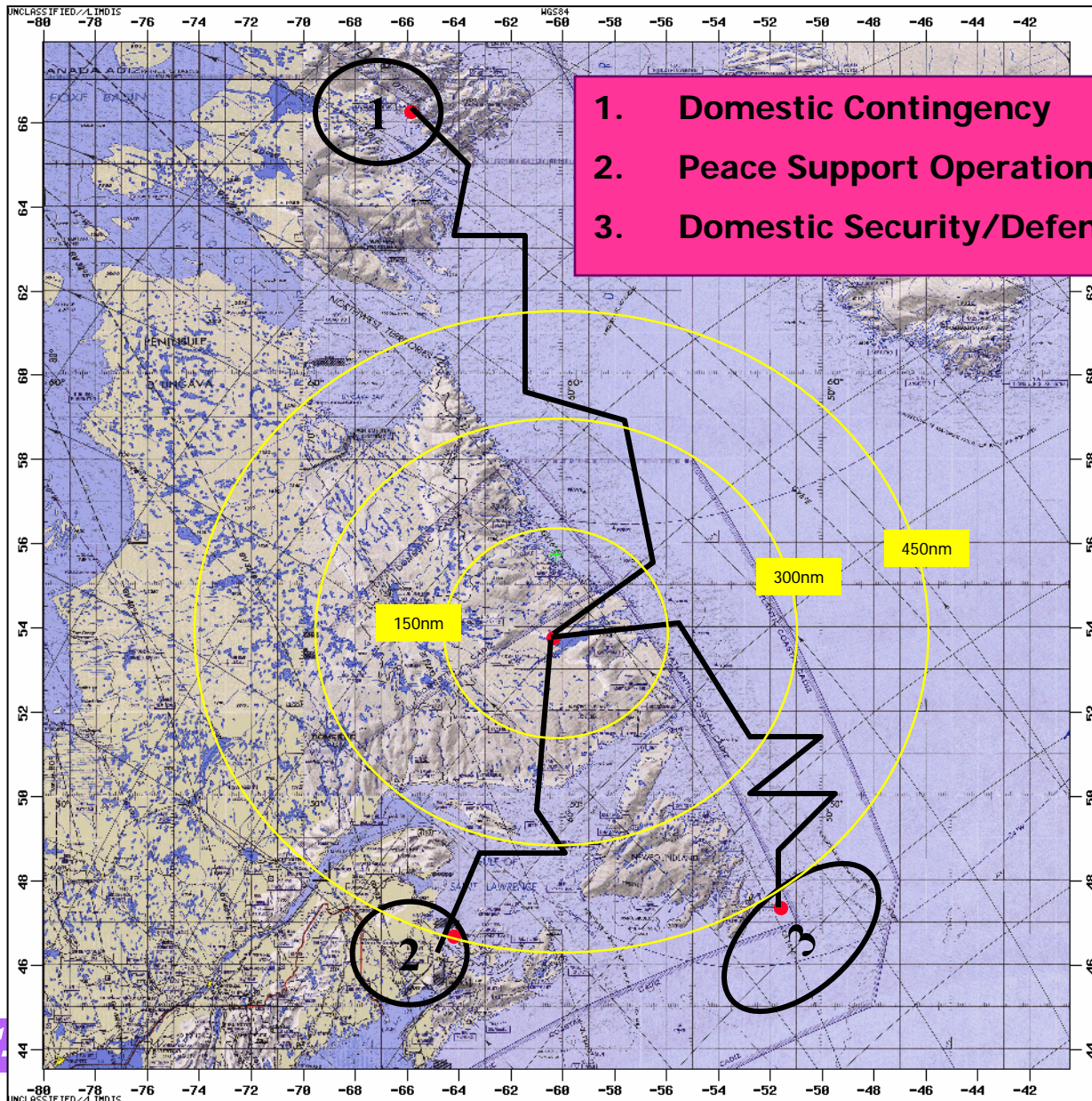
# ALIX Network Architecture



ALIX Trial - Top Level



# ALIX Area of Operations

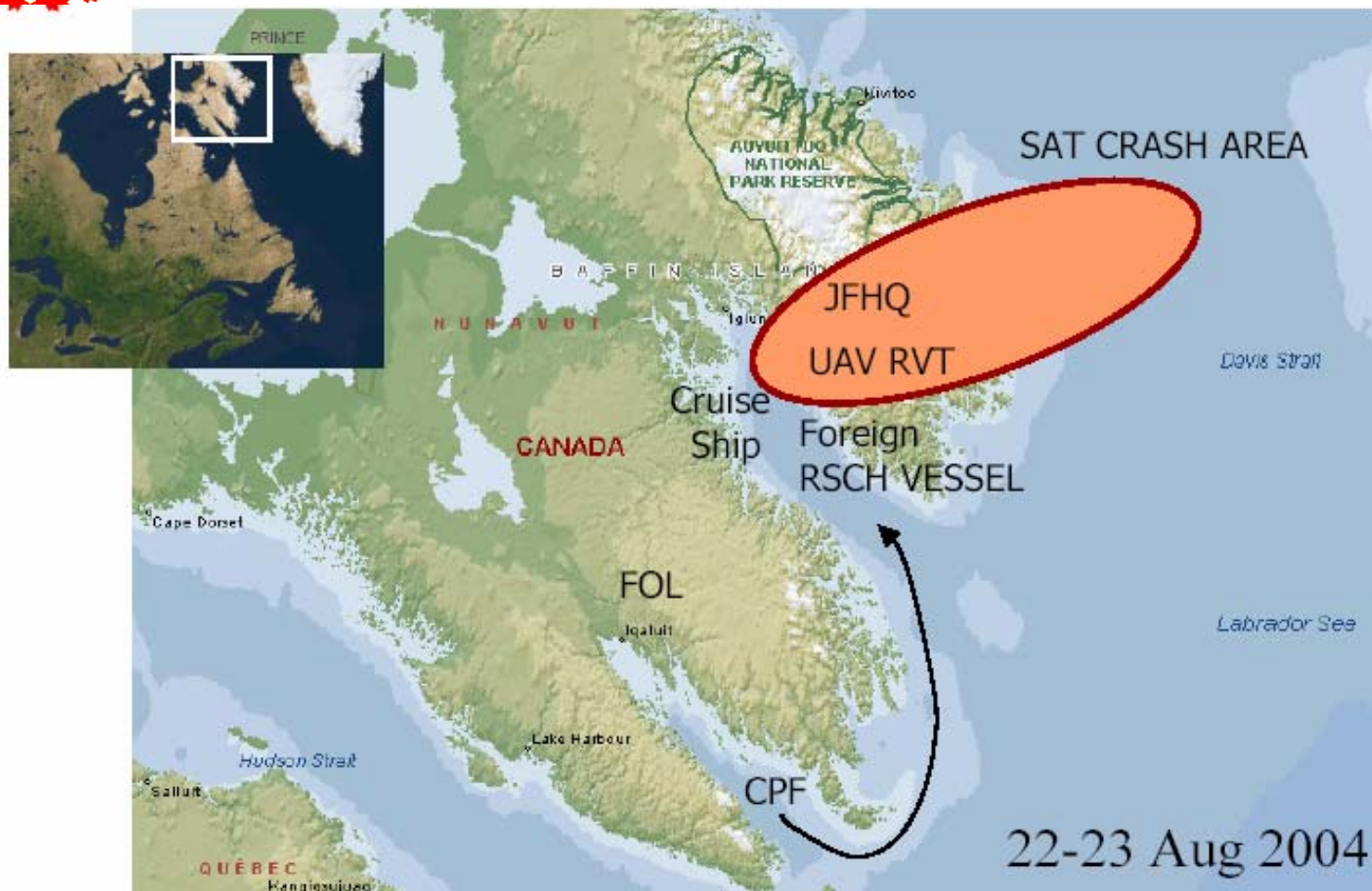


- 1. Domestic Contingency
- 2. Peace Support Operations
- 3. Domestic Security/Defence of Canada





## Scenario 1:





# ALIX Scenario 1

## SOVOP within CFNA (Narwhal '04)



- Situation: SAT Crash near Pangnirtung, Environment concerns, Foreign Nation Interest, Sensitive Payload
- Mission: Conduct focused surveillance of arctic area  
Support to civil authorities
- Success  
Criteria: Locate debris, timely ISR Support
- Tasks: Map & secure debris field, track intruders  
ISR Support to CFNA for recovery
- Forces: CFNA/JTFHQ, Infantry Coy, 1 CRPG, CPF, UAV, CH-146, Radarsat, Solicitor General, Coast Guard
- C4I: JTFHQ/CFNA, Maritime Operations Centre, ROC, NDCC



# Scenario 2





# ALIX Scenario 2

## Peace Support Op (ARCON '04)

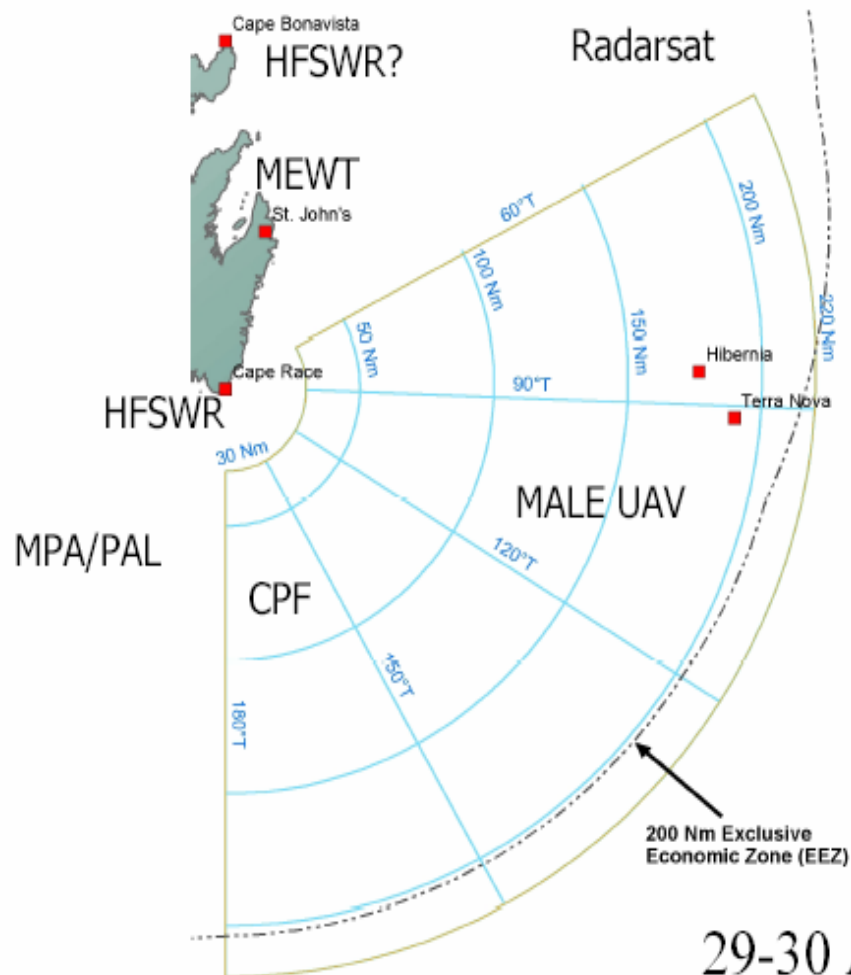


- Situation: UN Peace Support Operation (Chap 6)  
at Isle Gagetown
- Mission: Surveillance of Approaches,  
Support Ground forces, COP, BDA, TST
- Success  
Criteria: Timely identification/tracking of forces
- Tasks: Locate OPFOR, Classify & Identify Ground/air targets,  
Live fire targeting, BDA
- Forces: LFISTAR Tactical ASC, MALE/Mini UAVs, Coyote,  
ADATS, MEWT, MPA, DDH
- C4I: ARCON, JFHQ/MARLANT, LCC/LFAA, NDCC





# Questions



29-30 Aug 2004





# ALIX Scenario 3

## Marine Security



- Situation: Terrorist organization suspected of targeting Int'l Environmental Congress in St John's Nfld
- Mission: Timely threat warning,  
Surveillance of air and maritime approaches  
Support to civil authorities
- Success Criteria: Timely Detection of suspect activity,  
Track/ID vessels, Intercept VOI
- Tasks: Area Surveillance, Fish Patrol,  
Protection of vital points
- Forces: ROC, HFSWR, AIS, CP140, PAL, UAV,  
CBRN Team, ISTAR ASC, MEWT, Radarsat, OGDs
- C4I: ROC, NDCC, GoC PSEP/OC�PEP



# Estimate of Distance Covered





# Questions?



## Contact Info:

[BABCOCK.AA@FORCES.GC.CA](mailto:BABCOCK.AA@FORCES.GC.CA)

Phone: (613) 990-7455

Fax: (613) 991-5819